Chapter 1:
The Nature of Long-Term Stewardship at DOE Sites

The Estes Gulch Disposal Cell. This engineered unit near Rifle, Colorado contains approximately 3.6 million cubic yards of vanadium and uranium mill tailings and contaminated materials from uranium mining and milling operations at two uranium processing sites (the Old and New Rifle Sites) and more than 100 vicinity properties. The 62-acre cell, completed in 1996, consists of a 1-2 foot thick erosion barrier layer of cobble and boulders, a 3-7 foot thick frost protection layer of silt, a 1-2 foot thick clay radon barrier over the tailings, and a high-density polyethylene plastic liner beneath the tailings. Under the provisions of the Uranium Mill Tailings Control Act, the disposal cell is designed to be effective in control of residual radioactive materials for up to 1,000 years, and for at least 200 years. *Estes Gulch Disposal Cell, Rifle, Colorado, April 1998.*

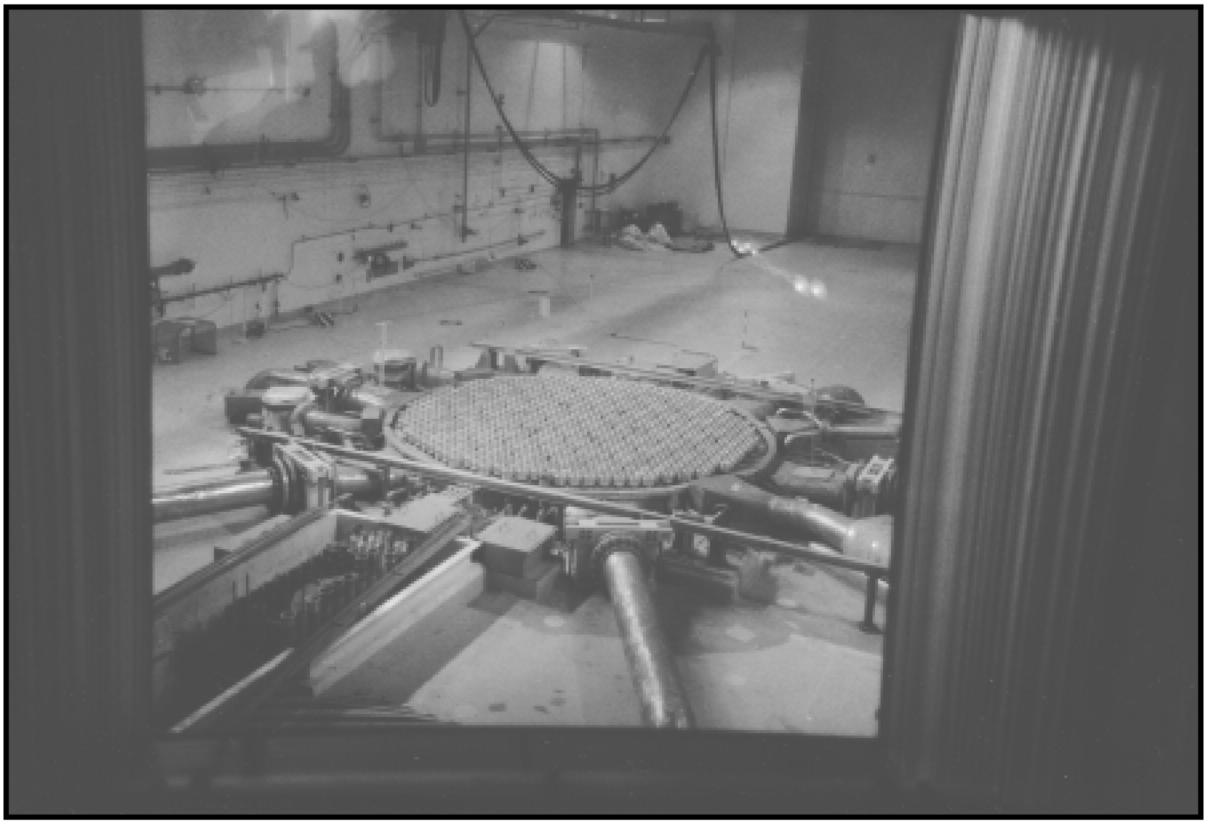
This chapter presents an overview of the hazards expected to remain at DOE sites after the assumed cleanup strategies have been implemented, and it discusses the activities required to protect humans and the environment from these hazards. It also views the regulatory context under which long-term stewardship has begun to be conducted. This report does not include materials or facilities that are part of two other programs that also use the word "stewardship:" the Nuclear Materials Stewardship Program, which provides for management and disposition of nuclear materials that are used or being stored at DOE sites; and the Stockpile Stewardship Program, which ensures the safety and reliability of the existing stockpile of nuclear weapons.

Key Definitions Used for this Analysis

Cleanup: The process of addressing contaminated land, facilities, and materials in accordance with applicable requirements. Cleanup does not imply that all hazards will be removed from the site. The term "remediation" is often used synonymously with cleanup.

End state: The physical state of a site after cleanup activities have been completed.

Long-term stewardship: All activities required to protect human health and the environment from hazards remaining after cleanup is complete.



K-Reactor Head. This nuclear reactor at the Savannah River Site was used during the Cold War to produce plutonium and tritium for nuclear weapons. Most of the radioactivity associated with the reactor was contained in the spent nuclear fuel, which has been removed for disposal. Nonetheless, some residual contamination will remain after the facility is deactivated, decommissioned and decontaminated, because there is no cost-effective technology for removing all of the contamination. Consequently, this facility will require some form of long-term stewardship after the current nuclear materials storage mission is completed between 2010 and 2016. *Savannah River Site, South Carolina, January 1994.*

Residual Hazards

A variety of hazards will remain at many DOE sites after these sites have been cleaned up to agreed upon levels. Exhibit 2 depicts the four categories of media where residual hazards will remain, including engineered units, soil and buried waste, facilities, and water. In some cases, cleanup reduces risks, but may not be able to reduce contaminant concentrations to levels deemed safe for unrestricted use of the site.

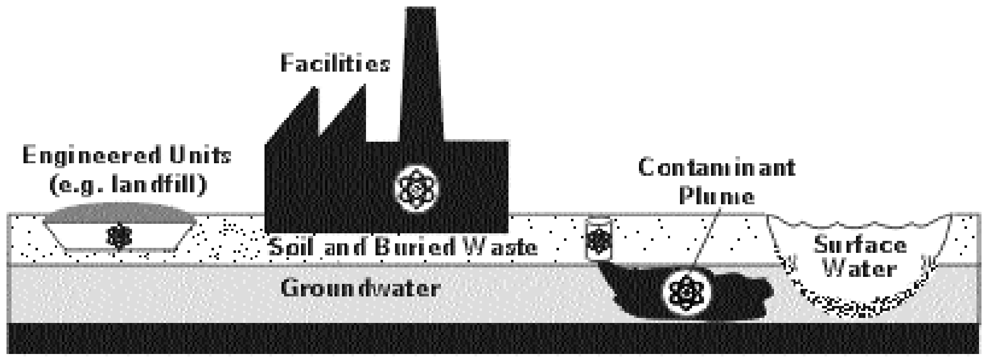
Cleanup goals are typically based on what is needed to allow the land or facility to be available for anticipated future uses. In many cases, however, hazards posed by these wastes and residual contaminants left in place may remain longer than the anticipated life of the engineered and institutional controls in place. If these controls fail, are not maintained, or are not as effective as anticipated, the remaining hazards could pose unacceptable risk.

Hazard and Risk

Hazards include materials or conditions that have the potential to cause adverse effects to health, safety, or the environment. Risk requires the presence of a hazard, but includes the probability that the potential harm will be realized.

Risk is expressed in terms of the likelihood that an adverse effect will occur as a result of the existence of a hazard. The existence of a hazard does not automatically imply the existence of a risk since risk requires a pathway (to a receptor) for an exposure to occur. Barriers and other controls can block or eliminate the pathway and consequently the risk from the residual hazard (see National Research Council 1988).

Exhibit 2: Examples of Residual Hazards at DOE Sites



Engineered Units

- Landfills and other land-based waste disposal units with engineered controls

Soil and Buried Waste

- Contaminants left in place in soils
- Old burial grounds

Facilities

- Entombed reactors, canyons, and other buildings with residual contamination

Water

- Residual contaminants in groundwater or surface water sediments

The need for stewardship at DOE sites results largely from the radioactive contaminants that will remain onsite and continue to pose some degree of risk indefinitely after cleanup is complete (see Exhibits 3 and 4). In addition to the long-lived radionuclides, other contaminants of concern that will remain onsite after cleanup is complete include organic and inorganic chemicals.

Organic contaminants include polychlorinated biphenyls (PCBs), chlorinated solvents, and polynuclear aromatics. Inorganic contaminants include mercury, arsenic, lead, cadmium, and asbestos. Unlike radiological constituents, chemical contaminants do not have well-defined rates of decay. Depending on site conditions, they may persist for a short time (as with some chlorinated organic solvents exposed to sunlight) or in perpetuity (as with inorganics, such as lead and asbestos).

Exhibit 3: Radiological Half Lives

Radioactive contaminants decay at a fixed rate, unaffected by factors such as temperature, solvents, or seasons of the year. The rate of decay is described by the half life – the amount of time required for one half of a given amount of a radionuclide to decay.

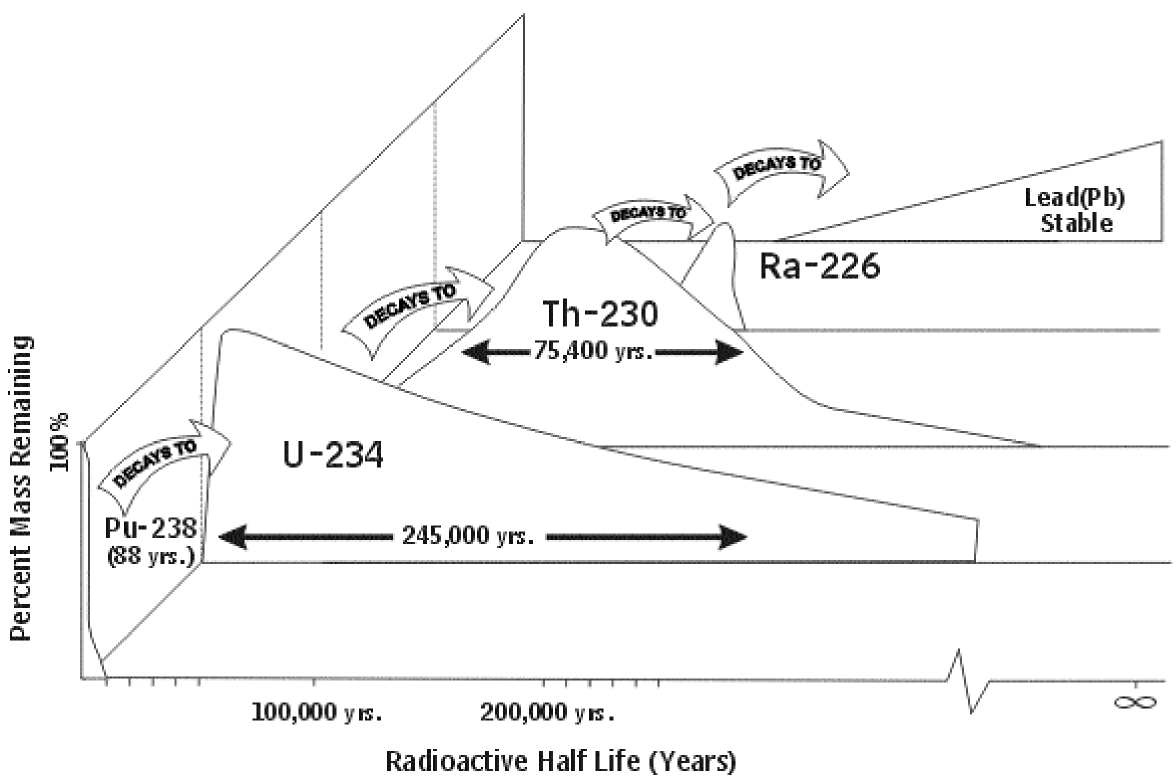
Radionuclide Half Lives

Curium-242	163 days
Cobalt-60	5 years
Tritium	12 years
Strontium-90	29 years
Cesium-137	30 years
Plutonium-238	88 years
Americium-241	432 years
Radium-226	1,600 years
Plutonium-239	24,100 years
Thorium-230	75,400 years
Technetium-99	211,100 years
Neptunium-237	2,144,000 years
Uranium-235	703,800,000 years
Uranium-238	4,468,000,000 years

The half life is inversely related to the rate of decay, and generally, to the intensity of radioactivity, so that a unit mass of a radionuclide having a half life of 100 years would undergo nuclear transformations at a rate 100 times lower than one with a half life of one year.

Source: National Nuclear Data Center

Exhibit 4: Some Radionuclides with Relatively Short Half Lives Decay into Radioactive Decay Products with Half Lives Measured in Geologic Time



Radiological constituents, or radionuclides, decay over time. As a radionuclide decays, it changes into a different radionuclide, or "decay product," by the spontaneous emission of an alpha particle, beta particle, or gamma rays, or by electron capture. Radionuclides decay at a fixed rate, unaffected by factors such as temperature or pressure. The fixed rate of decay is described by the "half life," which is the time required for half of the atoms of a given radionuclide to decay into a decay product. The decay product may have a shorter or longer half life than the radioactive isotope itself.

This Exhibit illustrates the radioactive decay chain of Plutonium-238. Plutonium-238, which has a radioactive half life of 88 years, decays to Uranium-234, which has a half life of 245,000 years. Uranium-234 decays to Thorium-230, which has a half life of 75,400 years. Thorium-230 decays to Radium-226, which has a half life of 1,600 years, and then to Radon-222 and shorter half life radionuclides (not shown in Exhibit) to Lead-206, a stable element. The Plutonium-238 decay chain illustrates that, although the Plutonium-238 itself would persist in the environment for approximately 880 years (10 half lives), the radioactive decay products would persist in the environment for hundreds of thousands of years before decaying into a stable, nonradioactive element (which itself is a hazardous substance).

Why Hazards Will Remain

Depending on the nature of the contaminant and the medium in which it is found, there are several limitations and challenges that preclude remediating many DOE sites to levels that would permit residential or other unrestricted land uses (see also pp. D-12 and D-13 of DOE 1996c).

Technical Limitations

At a number of DOE sites no complete remediation strategy currently exists, because of the type of contaminant and its location. For example, the high-level waste tanks at the Hanford and Savannah River sites pose particularly difficult technical challenges. Existing and projected technologies for removing liquid waste from these tanks will still

Canonsburg Disposal Cell. The 30-acre uranium mill tailings disposal cell in the center of the photograph is located in a residential area approximately 20 miles from Pittsburgh, Pennsylvania. Remedial actions were completed in 1985, and groundwater has been monitored since 1986. Annual groundwater monitoring will continue until 2004, and other long-term stewardship activities such as annual inspections and periodic vegetation control will be required indefinitely. Passive stewardship activities will include ensuring site access and groundwater use restrictions are maintained. *Canonsburg Disposal Cell, Canonsburg, Pennsylvania, March 1999.*

leave at least one percent of the waste in the bottom of the tanks. No technology currently exists to address these tank "heels." Furthermore, any action to remove the tanks may result in additional releases into the underlying soils.

Another difficult technical challenge includes sites where dense non-aqueous phase liquids (DNAPLs), such as trichloroethylene, trichloroethane, and tetrachloroethylene, were released into the subsurface during routine cleaning and maintenance operations (such contamination exists at the Lawrence Livermore National Laboratory in California and the Portsmouth Gaseous Diffusion Plant in Ohio).

Currently available groundwater treatment technologies are extremely inefficient at addressing DNAPL contamination. To date, the preferred remedy calls for stabilizing the groundwater plume (i.e., pumping groundwater in order to keep the plume from spreading) and monitoring until the DNAPLs naturally attenuate or break down into non-hazardous constituents. However, DNAPLs may take hundreds of years to break down or to attenuate.

Economic Limitations

Even when remediation technologies are available, the costs to employ them may be prohibitive. For example, large areas of the Nevada desert have been contaminated with radionuclides from nuclear weapons tests conducted during the Cold War. Although it is technically feasible to remediate identified hot spots of the surface contamination, the cost of remediating the hundreds of acres impacted by low levels of residual contamination across the entire site would be prohibitive.

Worker Health and Safety Challenges

In determining the remediation approach to sites, DOE and regulatory officials must balance the short-term risks to workers and potential longer-term risks to the general public. For example, DOE Savannah River Site officials, in conjunction with the Environmental Protection Agency (EPA) and South Carolina state officials, have signed Records of Decision agreeing that the best way to address some buried radioactive waste at the Savannah River Site is to contain it in place. DOE, EPA, and state officials agreed not to attempt to excavate an old disposal area near the center of the 310-square mile site, where more than 28,000 cubic meters of radioactive waste were buried from 1952 to 1974. Officials decided to evaluate alternative cleanup methods including stabilizing specific hot spots through grouting and covering the site with a surface barrier (i.e., “cap”). This decision to review alternatives to waste removal recognized that excavating the waste with existing technology would pose high risks to remediation workers. These risks were estimated to be much higher than the risks posed to off-site receptors if the waste was stabilized in-situ with long-term institutional controls.

To enhance cleanup and lower risks to workers, the Department has invested in science and technology research. For example, DOE has developed a robotic vehicle that can be lowered into a confined space where radiation levels may be unsafe for workers. This vehicle is used to perform investigations and help prepare waste and contaminated equipment for removal.

Collateral Ecological Damage Caused by Remediation

At some DOE sites a potential remedy may result in greater ecological damage than would occur by leaving the contaminated site undisturbed. This is often the case for contaminated surface waters and sediments. At the Oak Ridge Reservation, for example, sediment in the Clinch River has been contaminated with mercury and PCBs. These contaminants are bound to the sediment in the river bottom, becoming immobile; therefore, they represent relatively little risk to a small subpopulation (e.g., subsistence fishermen). One remediation strategy would involve dredging the sediment from the river bottom. Dredging, however, would cause the contaminants to be resuspended and transported downstream, spreading contamination and increasing the potential for exposure. Dredging and constructing temporary roads would also destroy surrounding vegetation and damage nearby wetlands. Therefore, the selected remedial alternative in this case is to leave the sediment in place, thus requiring long-term stewardship to ensure that the contaminants remain immobile and that access is restricted to prevent or limit human exposure.

Long-Term Stewardship Activities

Long-term stewardship involves a wide variety of activities, depending on the nature of the site conditions and/or the residual hazards. Overall requirements for stewardship over these sites and hazards are prescribed by statute, and additional requirements to implement these requirements are contained in regulations and DOE directives. In some cases, implementation plans and programs are defined to some degree in site-specific documents such as land use planning documents, environmental compliance documents and compliance agreements. In other cases, the plans and programs are not yet defined, but the general requirements for long-term stewardship are still applicable.

This background document focuses on identifying the sites and the basic site activities where long-term stewardship is expected to be required. These site-level stewardship activities include two general categories:

1. Active controls entail performing certain activities to control risk at a site on a relatively frequent or continuous basis, such as operating, maintaining and monitoring the engineered controls implemented at sites, including caps, other physical barriers, and groundwater pump-and-treat systems. This could include practical tasks such as repairing fences and erosion gullies, and collecting water samples (or using less expensive monitoring technologies yet to be developed).
2. Passive controls generally entail less intensive tasks required to convey information about site hazards and/or limiting access through physical or legal means. Passive controls could include ensuring the continued effectiveness of applicable controls, including physical systems (e.g., fences and other barriers), governmental controls (e.g., ordinances and building permits), and proprietary controls (e.g., deeds and easements).

Decisions about these activities are expected to be part of the local decision-making process during cleanup (and have typically been included explicitly in long-term surveillance and monitoring permits for uranium mill tailings sites with the Nuclear Regulatory Commission (NRC)). They are introduced here to provide background for involving regulators, Tribal, state and local governments, and other stakeholders as those local decisions are made.

In addition, there are a variety of other tasks, which may not occur at a local site level, that will likely be needed for an effective long-term stewardship program. These include:

- Supporting and evaluating new technologies as they develop that may be useful in reducing the long-term stewardship costs, improving performance, or performing a permanent remedy that obviates the need for long-term stewardship as well as improving our understanding of the health and environmental impacts of residual contaminants;
- Emergency response;
- Compliance oversight;
- Natural and cultural resource management;
- Information management;
- Budget preparation, and other administrative support; and
- Site redevelopment, and community liaison and planning.

These issues are not addressed in as much depth in this background document, and are expected to be among the broader programmatic issues addressed in the study being performed pursuant to the December 1998 Settlement Agreement.

Other terminology has been used to describe long-term stewardship activities. For example, EPA regulations (40 CFR 191) define the term "institutional controls" to encompass all three of the types of activities considered as "long-term stewardship" in this background document. According to these regulations, active institutional control means:

- Controlling or cleaning up releases from a site;
- Performing maintenance operations or remedial actions at a site;
- Monitoring parameters related to disposal system performance; or
- Controlling access to a disposal site by any means other than passive institutional controls.

Passive institutional control means:

- Permanent markers placed at a disposal site;
- Government ownership and regulations regarding land or resource use;
- Public records and archives; and
- Other methods of preserving knowledge about the location, design, and contents of a disposal system.

Exhibit 5 illustrates some stewardship activities that may be conducted at the sites and highlights some of the technical uncertainties that the Department currently is facing (additional information on stewardship activities can be found in ICF 1998).

Mound Plant. Located in Miamisburg, Ohio, the plant was used to produce actuators, ignitors, and detonators for nuclear weapons. DOE has begun transferring parts of the site to the Miamisburg Mound Community Improvement Corporation for reuse as a commercial/industrial complex and is expected to complete most of this transfer by 2005. The site is being cleaned up to meet industrial land use standards, and institutional controls in the form of deed restrictions will be placed on the transferred property to maintain land use restrictions. *Mound Plant, Miamisburg, Ohio, May 1984.*

Waste Pit Area at Fernald. This area was used for the disposal of process-related waste generated when site workers converted uranium ore into uranium metal and fabricated it into target elements for reactors that produced weapons-grade plutonium and tritium. When remediation is complete at this site, all facilities will be demolished but a 138-acre disposal facility for radioactive and hazardous waste will remain onsite similar to the Weldon Spring Site (see page 7). The Fernald site will require institutional controls and groundwater monitoring at the disposal facility in perpetuity. Remediated areas will be available for conservation or recreational purposes. *Fernald Environmental Management Project, Ohio, January 1994.*

Exhibit 5: Examples of Potential Site Stewardship Activities and Technical Uncertainties

Media Potentially Subject to Stewardship	Possible Stewardship Activities	Examples of Technical Uncertainties
Water All contaminated groundwater and surface water sediments that cannot or have not been remediated to levels appropriate for unrestricted use	• Verification and/or performance monitoring • Use restrictions, access controls (site comprehensive land use plan) • Five-year (or comparable) review requirements • Resource management to minimize potential for exposure	• What is the likelihood that residual contaminants will move toward or impact a current or potential potable water source? • Are dense non-aqueous phase liquids (DNAPLs) or long-lived radionuclides present in concentrations and/or locations different than those identified? • Will treatment, containment, and monitoring programs remain effective and protective? • Will ambient conditions change significantly enough to diminish the effectiveness of the selected remedy (i.e., monitored natural attenuation) or allow resuspension of stabilized contaminants in sediments?
Soils All surface and subsurface soils where residual contamination exists or where wastes remain under engineered, vegetative, or other caps	• Institutional controls to limit direct contact or food chain exposure • Maintaining engineered, asphalt, or clean soil caps • Permit controls, use restrictions, markers (site comprehensive land use plan) • Five-year (or comparable) remedy review requirements	• What is the likelihood of future contaminant migration if ambient conditions change? • How will changes in land use affect the barriers in place to prevent contaminant migration and potential exposure? • What is the likelihood of cap failure sooner than anticipated? • What is the effect of contaminant degradation on remedy components (e.g., cap, vegetation)?
Engineered Units All land-based waste disposal units with engineered controls	• Monitoring and inspections, per agreements, orders, or permits • Institutional controls, including restricted land use • Maintenance, including repairing caps • Five-year (or comparable) review requirements • Land and resource planning to minimize potential for exposure (site comprehensive land use plans)	• What is the effect of contaminant degradation on remedy components (e.g., liners, leachate collection systems, caps)? • At what point in time will the remedy require significant repair or reconstruction? • Is the monitoring system robust enough to capture remedy failure?
Facilities Buildings and other structures that are no longer in use, which are contaminated, or whose future plans call for maintaining the structure with contamination in place	• Monitoring, inspections, and safeguard and securities measures • Access restrictions • Five-year (or comparable) review requirements • Site reuse or redevelopment controls to minimize the potential for exposure (site comprehensive land use plan)	• Will current controls remain adequate to maintain protection of facilities? • How will fixed residual contamination remain adequately controlled given current facility uses?

Low-Level Waste Disposal Site. This engineered trench at the Savannah River Site contains approximately 30,000 stacked carbon-steel boxes of waste with each box measuring 4 by 4 by 6 feet. In 1996 the trench was backfilled with dirt to form a mound, which was seeded with grasses and sloped to reduce runoff. Long-term monitoring and maintenance will be needed to ensure the integrity of this waste containment system. *Engineered Low-Level Trench 4, Savannah River Site, South Carolina, January 1994.*

Regulatory Context

The Department conducts its stewardship activities in compliance with applicable laws, regulations, interagency agreements, and site-specific compliance agreements. Appendix B highlights some of the more significant statutes affecting DOE.

The Atomic Energy Act provides authority for the Department to protect the health and safety of the public from hazards associated with sources of radiation under its control. This responsibility encompasses properties with radioactive material, including radioactive waste disposal facilities.

DOE's waste disposal practices are subject to a variety of post-disposal care requirements. Applicable laws, regulations, and DOE Orders vary by waste type (e.g., transuranic waste, low-level waste; see Appendix B); however, DOE is generally required to implement controls at waste disposal sites in perpetuity. For example, mill tailing standards promulgated by EPA (40 CFR 192) prescribe institutional control requirements such as land ownership and DOE oversight and maintenance of mill tailings disposal facilities. These activities are conducted by DOE under a permanent license issued by the NRC under 10 CFR 40. As another example, NRC licensing criteria being developed for the proposed geologic repository would require that passive control measures be designed to serve their intended purpose for as long as practicable (64 FR 8640).

Regulations applicable to waste disposal facilities may include design standards that have specific time frames associated with them. For example, 40 CFR 192.02(a) requires that controls for mill tailing sites be effective for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Design standards having specified time frames are developed to balance capital costs with expected maintenance costs. Controls with a design criteria of 10,000 years would be very expensive to construct, but inexpensive to maintain. Controls with a design criteria of 100 years would be inexpensive to construct, but would require more maintenance. In any case, uranium mill tailings sites contain wastes containing uranium-238 and thorium-230 with half-lives of 4.47 billion years and 75,400 years, respectively. It therefore is expected that controls established for mill tailing sites will require monitoring and maintenance activities to be conducted far beyond the time frame of the design standards.

Regulatory requirements for disposal systems for transuranic waste require that these systems be designed to provide a reasonable expectation that the cumulative releases of radionuclides to the environment for 10,000 years will not exceed exposure standards (40 CFR 191.13 and 191.15). The 10,000 year period upon which the performance assessment for the disposal system is based is less than the half lives of common transuranic elements (see Exhibit 4). Also, the regulations for transuranic disposal systems do not allow applicants to assume that active institutional controls will be effective more than 100 years (40 CFR 191.14a), even though the regulations also require that the applicant maintain active institutional controls for as long a period as practicable after disposal (40 CFR 191.14(a)).

Stewardship and Land Use

Future land use, cleanup strategies, and long-term stewardship needs are interdependent. Future use goals are an important factor in determining cleanup strategies and associated stewardship needs. However, the technological and other limitations discussed earlier will limit the range of attainable future use options. Furthermore, ongoing DOE missions (e.g., safeguarding nuclear materials, maintaining waste disposal cells, research and development activities, and performing trustee responsibility for cultural and ecological resources) may predetermine future use for affected areas of sites.

In the absence of a future non-EM site mission, some DOE property, if releasable, can be declared excess and transferred to other Federal or non-Federal entities. Such transfers require legal agreements and institutional controls to maintain ongoing long-term stewardship responsibilities.

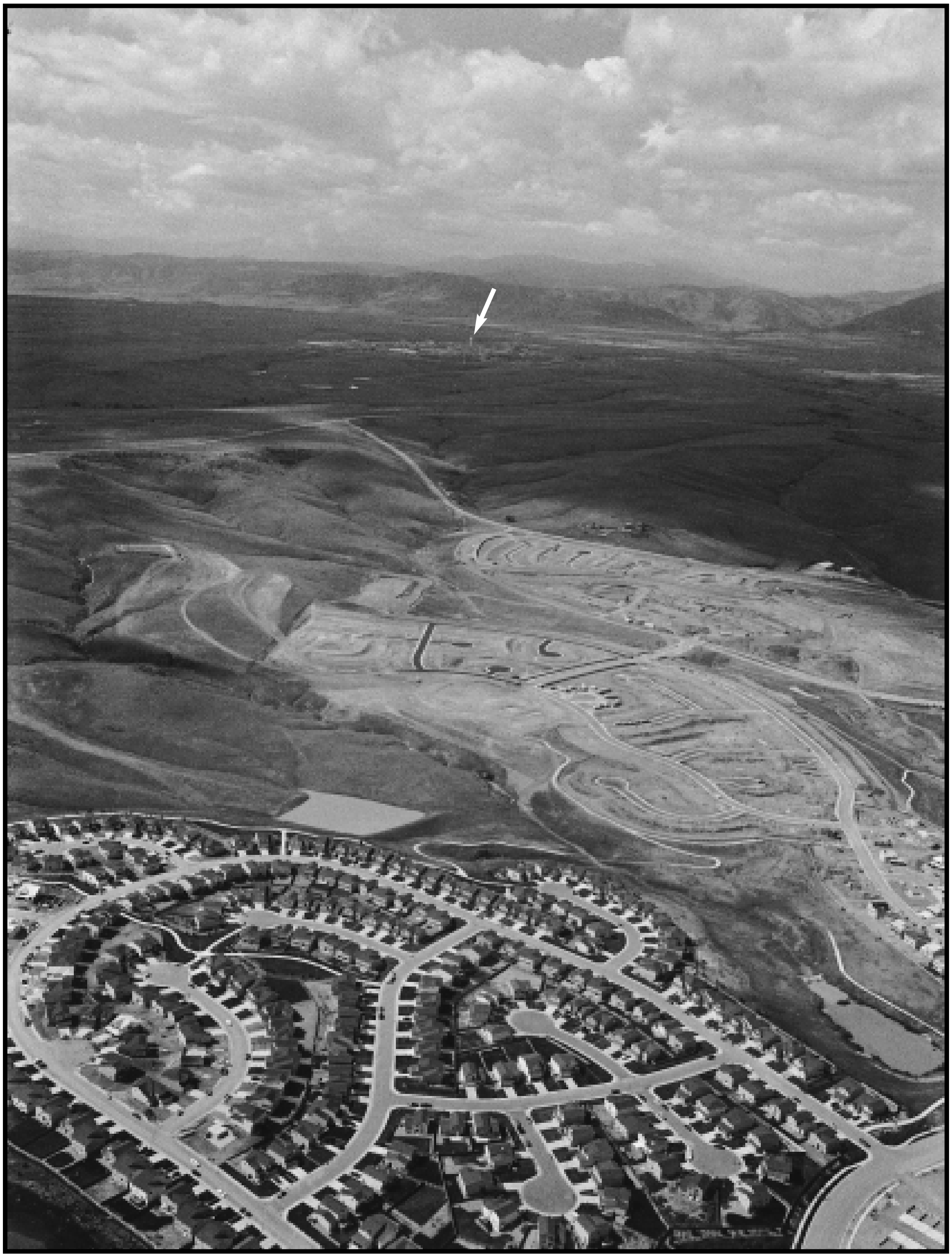
Exhibit 6 illustrates the importance of future use planning as urban areas expand and approach the boundaries of some of the Department's facilities.

A key element of many long-term stewardship programs will likely be the use of institutional controls—including governmental and proprietary controls—to ensure that land use restrictions are maintained. Local government controls include deed restrictions, zoning restrictions, permit programs, well-drilling restrictions, and other restrictions that are traditionally established by local governments. Proprietary controls include deed restrictions, easements, and restrictive covenants that are based on state property law. Successful implementation of these institutional controls will require coordination between Federal agencies as well as Tribal, state, and local governments.

Long-Term Stewardship Not Unique to DOE

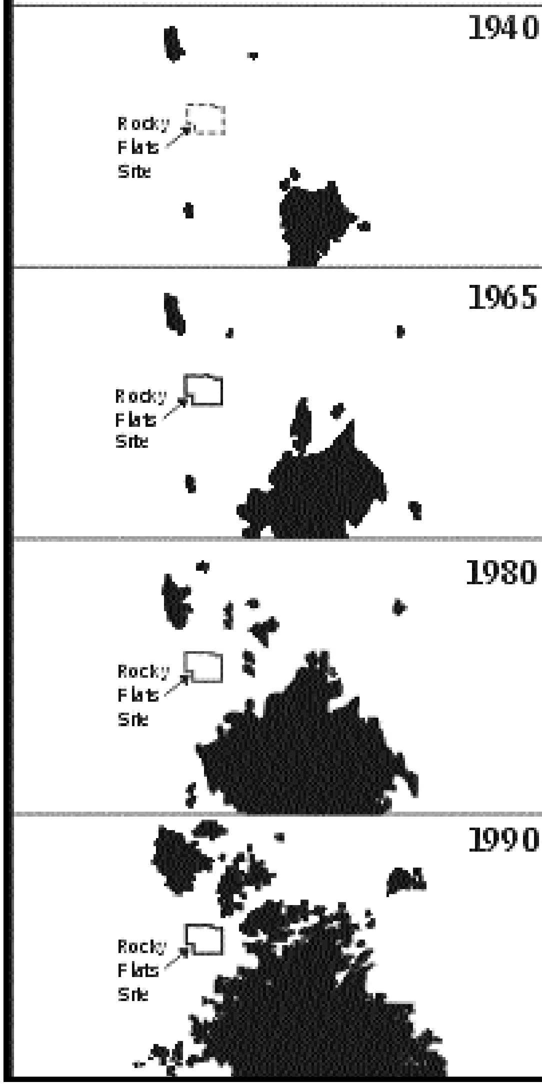
Although DOE sites are the subject of this report, stewardship responsibilities are not unique to the Department. At least three other Federal agencies are involved in cleanup programs at other sites that will result in residual hazards and require some type of stewardship after completion. The extent of long-lived radionuclide contamination distinguishes DOE from other Federal agencies, but the issues and challenges faced by other agencies are similar to those the Department must address.

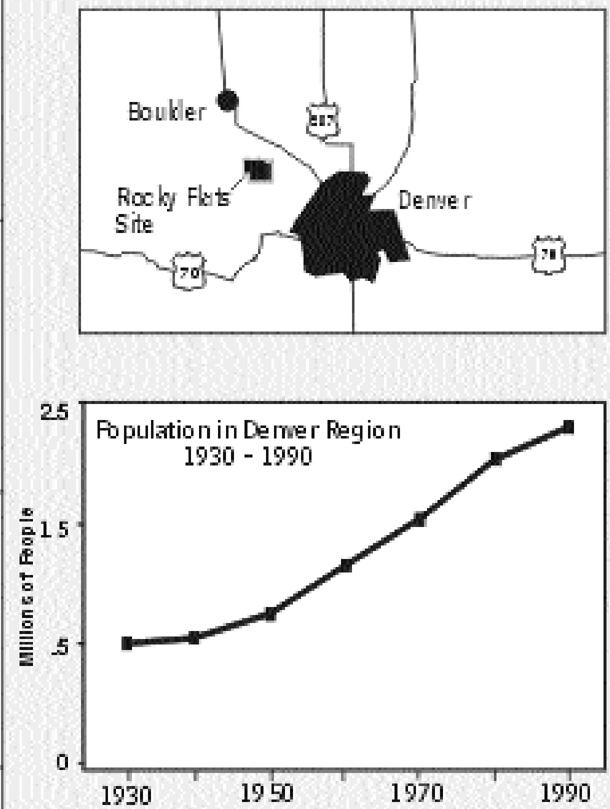
Representatives of EPA's Federal Facilities Restoration and Reuse Office have participated in long-term stewardship workshops sponsored by DOE and have recognized that long-term stewardship is critical to reducing the risk posed by remaining hazards. EPA is currently determining its stewardship responsibilities and is in the



Residential Development Towards the Rocky Flats Environmental Technology Site. More than 2 million people live within a 50-mile radius of the Rocky Flats site, visible in the upper center of this photo. This population is expected to increase by 30 percent within the next 20 years. Residential areas now border the northeastern edge of the site's Buffer Zone. Current cleanup plans would result in an interim end state with caps over some soils and landfills, with the foundations and utilities of some facilities left in place, and with passive systems for treatment and containment of contaminated groundwater. Long-term stewardship requirements will include surveillance and maintenance of engineered caps, long-term monitoring of groundwater and surface water quality, and institutional controls to maintain land use restrictions. *Rocky Flats Environmental Technology Site, Colorado, September 1999.*

Exhibit 6: Demographic Changes Near the Rocky Flats Site





The Rocky Flats Site is located 17 miles northwest of Denver, Colorado. The site became operational in 1951. Four maps to the left illustrate the growth of suburban development from Denver to Boulder toward the once isolated Rocky Flats Site. The graph above charts the nearly five-fold population increase in the Denver area since 1930.

preliminary stages of reviewing options, including creating a stewardship program under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) or amending the National Contingency Plan (NCP) to define post-closure responsibilities at Superfund sites.

In support of these initiatives, EPA has recently developed several guidance documents on the use and implementation of institutional controls. Both EPA Region IV and Region X have released policy documents on the use of institutional controls at Federal facilities, and EPA headquarters is developing a reference manual on institutional controls and their criteria at Federal facilities being transferred under CERCLA §120(h). EPA is also making progress in determining post-closure responsibilities at "brownfields" sites, which are abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. However, the specific ways in which long-term institutional control issues are implemented vary considerably at state and local levels.

The Department of Defense (DoD) conducts cleanup activities at more than 10,000 sites - nearly

2,000 contaminated military installations and more than 9,000 formerly used defense properties – through its Defense Environmental Restoration Program. To some degree, remediation challenges posed by DoD sites are similar to those at DOE sites – they are often large tracts of land, frequently used for multiple purposes, and commonly contaminated with many constituents. Contamination at DoD facilities typically involves organic chemicals, such as solvents (e.g., trichloroethylene) or jet fuel; inorganic chemicals such as metals; and sometimes radioactive materials, though much less frequently and in much smaller quantities than at DOE sites. DoD sites also present similar stewardship challenges to those DOE is facing, including maintaining access controls; monitoring, pumping and treating groundwater; implementing monitored natural attenuation; and maintaining long-term caps. DoD faces unique, often difficult, challenges in determining the best way to remediate weapons ranges, many of which contain unexploded ordnance. Currently, DoD is working in several areas to address these and other long-term care issues. A multi-agency task force, led by the Air Force Base Conversion Agency, is preparing guidance for Defense installations on navigating the CERCLA and RCRA processes from the time the remedy is in place to the time of site closeout. The guidance, *The Road to Site Closure*, is expected to be final by spring of 2000. The draft document is available online at *http://www.afbca.hq.af.mil/closeout*.

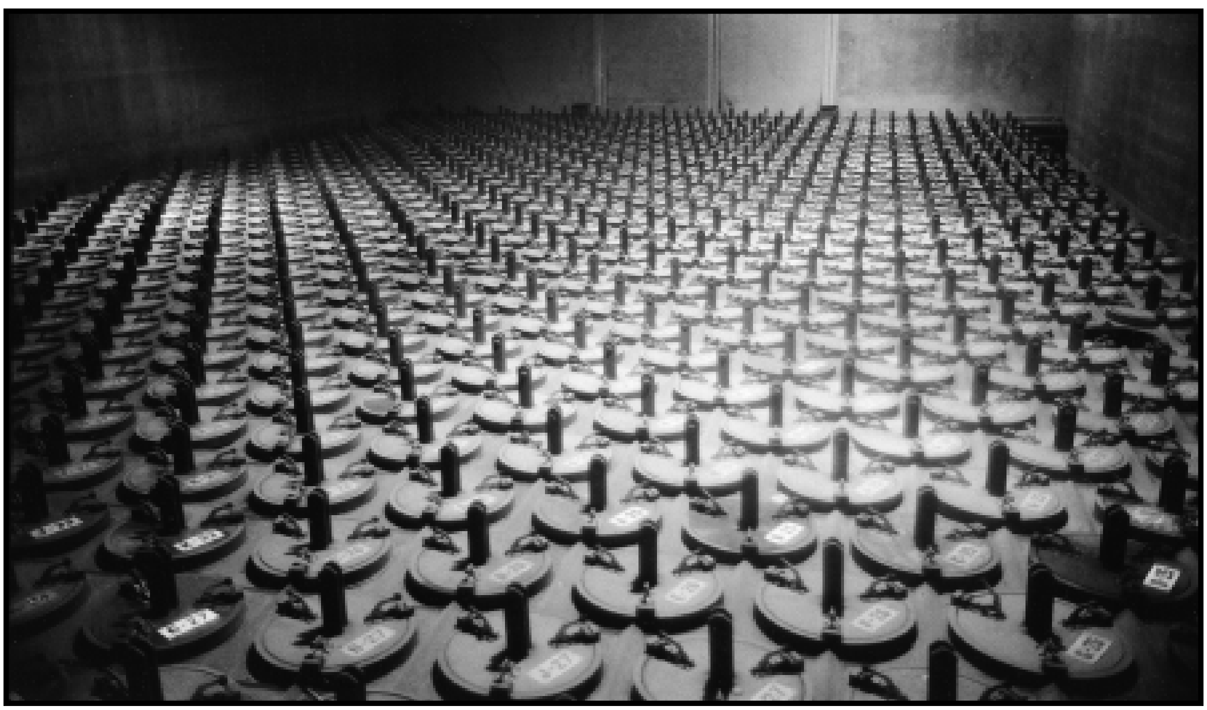
The Department of the Interior (DOI) is responsible for overseeing approximately 13,000 former mining sites, some of which have been abandoned by the original owners. Hazards remaining at former mining sites include byproducts such as tailings and leachates, blasting caps, wires, and open holes. Because many mining sites are so large, remediation is often infeasible and institutional controls will be heavily relied upon.

NRC regulates and licenses commercial, industrial, academic and medical uses of nuclear energy. NRC also regulates private sector and DOE uranium mill tailing sites cleanup projects and resulting disposal cells. NRC has developed regulations that address long-term stewardship at sites where unrestricted use is not attainable (10 CFR 20.1403(c)). These regulations require the facility to reduce residual radioactivity as low as reasonably achievable, provide for legally enforceable institutional controls, provide financial assurance for long-term control and maintenance of the site, submit a decommissioning plan, and demonstrate that annual doses will not exceed specified levels if the institutional controls are ineffective. Once the above requirements are met, NRC no longer regulates the site. Typically, oversight of the institutional controls and long-term stewardship is accepted by another Federal agency (including DOE) or a state or local government entity. For example, after NRC decommissioned mill buildings, consolidated mill tailings, and fenced off the disposal cell at the private Arco Bluewater facility in New Mexico, the site was transferred to DOE for long-term surveillance and monitoring.

The nation's commitment to long-term stewardship is not limited to radioactive materials, DOE sites, or Federal sites; it is intrinsic to the management of other types of waste and sources of contamination across the nation. For example, sanitary and hazardous landfills include long-lived hazardous constituents such as metals and organic compounds. Leachate from some of these landfills has contaminated groundwater resources. Furthermore, many industrial facilities and former waste management facilities (e.g., impoundments and storage facilities) contain long-lived hazardous constituents. At least part of the burden for long-term stewardship of these areas and facilities is likely to fall on state and local governments and/or the private sector.

Given the diversity of issues and types of sites, the Department is seeking to coordinate its long-term stewardship activities with Federal, state and local officials, Tribes, and stakeholders.

Trinity Explosion Marker. Located in the Alamogordo Desert in southern New Mexico, this small obelisk marks ground zero at the Trinity Site, the exact location of the first atomic explosion that occurred on July 16, 1945. The site was designated a national historic landmark in 1975. Because the site is located within the White Sands Missile Range, a secured site maintained by DoD, visitors may access the site only two days a year. *Trinity Site, White Sands Missile Range, New Mexico, circa 1985.*



Irradiated Nuclear Fuel in Dry Storage. Spent nuclear fuel is a highly radioactive material that has not been reprocessed to remove the constituent elements. This waste must be stored in facilities that shield and cool the material. DOE plans to remove all spent nuclear fuel from the site by 2035 and dispose of it in the proposed geologic repository. *Building 603, Idaho Nuclear Technology and Engineering Center, formerly the Idaho Chemical Processing Plant, Idaho National Engineering and Environmental Laboratory, Idaho, March 1994.*